

THAT WHICH IS CLAIMED:

1. A method of modeling a dye, said method comprising:
determining a transmittance of the sample treated with the dye from a color image
5 of the treated sample, the image comprising a plurality of pixels, in each of a red, green, and blue channel of an RGB color space and for each pixel of the image so as to form an RGB triplet for each pixel;

grouping the RGB triplets according to the minimum transmittance in the red, green, and blue channels for the respective RGB triplet;

10 normalizing each group of RGB triplets by summing the transmittances in each of the respective red, green, and blue channels and then dividing each of the summed transmittances by the number of RGB triplets in the respective group so as to form respective normalized RGB triplets; and

15 tabulating the normalized RGB triplets according to the minimum transmittance of each normalized RGB triplet so as to form a correspondence table for the dye, the correspondence table extending in transmittance increments between 0% and 100% transmittance.

2. A method according to Claim 1 further comprising capturing an image of

20 the treated sample with a color image acquisition device so as to form the color image of the treated sample.

3. A method according to Claim 1 further comprising determining, when a transmittance increment in the correspondence table is without a normalized RGB triplet,
25 an approximated transmittance in each of the red, green, and blue channels so as to form an approximated normalized RGB triplet for that transmittance increment.

4. A method according to Claim 3 wherein determining the approximated normalized RGB triplet further comprises determining a reference transmittance increment having a normalized RGB triplet, both at a higher transmittance increment and a lower transmittance increment in the correspondence table, with respect to the

transmittance increment without the normalized RGB triplet, and then interpolating between the respective transmittances in each of the red, green, and blue channels of the reference transmittance increments so as to form an approximated normalized RGB triplet for the transmittance increment without the normalized RGB triplet.

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5. A method according to Claim 1 further comprising establishing a significance threshold for the number of RGB triplets in a group and, for any group failing to meet the significance threshold, discarding the RGB triplets therein as being insignificant.

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6. A method according to Claim 1 further comprising plotting the RGB triplets for the pixels of the image in an RGB color space so as to obtain a three-dimensional RGB representation of the respective dye, prior to normalizing each group of RGB triplets.

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7. A method according to Claim 1 further comprising plotting the normalized RGB triplets in an RGB color space so as to obtain a characteristic RGB path of the respective dye through the RGB color space.

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8. A method according to Claim 1 further comprising plotting the normalized RGB triplets on a one-dimensional scale so as to graphically represent the correspondence table.

25 9. A method according to Claim 2 wherein capturing an image of the treated sample further comprises capturing an image of the sample in a video microscopy system with at least one of an RGB camera and an RGB-configured scanner.

10. A method according to Claim 2 wherein capturing an image of the treated sample further comprises illuminating the sample under Koehler illumination conditions.

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11. A method according to Claim 2 wherein capturing an image of the treated sample further comprises capturing an image of the sample in a chromatic aberration-corrected video-microscopy system.

5 12. A method according to Claim 2 wherein capturing an image of the treated sample further comprises illuminating the sample with a light source and determining a transmitted intensity of the light transmitted therethrough in each of the red, green, and blue channels.

10 13. A method of modeling a combination of a plurality of dyes, said method comprising:

forming a correspondence table for each of the plurality of dyes; and
orthogonally adding the correspondence tables of the plurality of dyes so as to
form a dye space representation of the plurality of dyes, the dye space
representation having one dimension for each dye and providing a
reference model for a combination of the plurality of dyes.

15 14. A method according to Claim 13 wherein forming a correspondence table for each of the plurality of dyes further comprises:

20 determining a transmittance of a sample treated with the respective dye from a
color image of the treated sample, the image comprising a plurality of
pixels, in each of a red, green, and blue channel of an RGB color space
and for each pixel of the image so as to form an RGB triplet for each
pixel;

25 grouping the RGB triplets according to the minimum transmittance in the red,
green, and blue channels for the respective RGB triplet;
normalizing each group of RGB triplets by summing the transmittances in each of
the respective red, green, and blue channels and then dividing each of the
summed transmittances by the number of RGB triplets in the respective
group so as to form respective normalized RGB triplets; and

tabulating the normalized RGB triplets according to the minimum transmittance of each normalized RGB triplet so as to form the correspondence table for the respective dye, the correspondence table extending in transmittance increments between 0% and 100% transmittance.

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15. A method according to Claim 14 further comprising capturing an image of the treated sample with a color image acquisition device so as to form the color image of the treated sample.

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16. A method according to Claim 14 further comprising determining, when a transmittance increment in the correspondence table for a dye is without a normalized RGB triplet, an approximated transmittance in each of the red, green, and blue channels so as to form an approximated normalized RGB triplet for that transmittance increment.

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17. A method according to Claim 16 wherein determining the approximated normalized RGB triplet further comprises determining a reference transmittance increment having a normalized RGB triplet, both at a higher transmittance increment and a lower transmittance increment in the correspondence table for the dye, with respect to the transmittance increment without the normalized RGB triplet, and then interpolating between respective transmittances in each of the red, green, and blue channels of the reference transmittance increments so as to form an approximated normalized RGB triplet for the transmittance increment without the normalized RGB triplet.

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18. A method according to Claim 14 further comprising establishing a significance threshold for the number of RGB triplets in a group and, for any group failing to meet the significance threshold, discarding the RGB triplets therein as being insignificant.

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19. A method according to Claim 14 further comprising plotting the RGB triplets for the pixels of the image in an RGB color space so as to obtain a three-

dimensional RGB representation of the respective dye, prior to normalizing each group of RGB triplets.

20. A method according to Claim 14 further comprising plotting the RGB
5 triplets for the pixels of the images for each of the plurality of dyes in an RGB color
space so as to obtain a three-dimensional representation of a combination of the plurality
of dyes, prior to normalizing each group of RGB triplets.

10 21. A method according to Claim 14 further comprising plotting the
normalized RGB triplets in an RGB color space so as to obtain a characteristic RGB path
of the respective dye through the RGB colorspace.

15 22. A method according to Claim 14 further comprising plotting the
normalized RGB triplets on a one-dimensional scale so as to graphically represent the
correspondence table.

20 23. A method according to Claim 13 wherein orthogonally adding the
correspondence tables of the plurality of dyes further comprises orthogonally adding the
correspondence tables of the plurality of dyes according to the Lambert-Beer law.

25 24. A method according to Claim 13 further comprising plotting the dye space
representation of the plurality of dyes on a scale having a number of dimensions
corresponding to the number of dyes.

30 25. A method according to Claim 13 wherein orthogonally adding the
correspondence tables of the plurality of dyes further comprises orthogonally adding the
correspondence tables of the plurality of dyes so as to form a resultant correspondence
table for the combined plurality of dyes the resultant correspondence table comprising a
plurality of resultant RGB triplets extending between 0% and 100% transmittance.

26. A method according to Claim 15 wherein capturing an image of the treated sample further comprises capturing an image of the sample in a video microscopy system with at least one of an RGB camera and an RGB-configured scanner.

5 27. A method according to Claim 15 wherein capturing an image of the treated sample further comprises illuminating the sample under Koehler illumination conditions.

10 28. A method according to Claim 15 wherein capturing an image of the treated sample further comprises capturing an image of the sample in a chromatic aberration-corrected video-microscopy system.

15 29. A method according to Claim 15 wherein capturing an image of the treated sample further comprises illuminating the sample with a light source and determining a transmitted intensity of the light transmitted therethrough in each of the red, green, and blue channels.

20 30. A method of determining an amount of at least one molecular species comprising a sample, each molecular species being indicated by a dye, from an image of the sample captured by an image acquisition device, the image comprising a plurality of pixels, said method comprising:

25 forming a dye space representation of a plurality of dyes, each dye having a corresponding correspondence table comprising a plurality of normalized RGB triplets, the dye space representation having one dimension for each dye and providing a reference model for a combination of the plurality of dyes;

30 comparing each pixel of the image of the sample, the sample being treated by the combination of the plurality of dyes, to the reference model for the combination of the plurality of dyes, each pixel having a color defined by an RGB triplet, so as to determine an optimal combination of normalized RGB triplets from the respective correspondence tables of the dyes

producing the color of the respective pixel, the normalized RGB triplets of the optimal combination being identifiable according to the respective dye; and

5 forming an artificial image of the sample, the artificial image corresponding to the sample image, from the normalized RGB triplets for each dye determined from the optimal combination, the artificial image thereby indicating a distribution of the respective dye over the sample image and facilitating determination of the amount of the corresponding molecular species.

10 31. A method according to Claim 30 wherein forming a dye space representation further comprises:

15 forming a correspondence table for each of the plurality of dyes; and orthogonally adding the correspondence tables of the plurality of dyes so as to form the dye space representation of the plurality of dyes.

15 32. A method according to Claim 31 wherein forming a correspondence table for each of the plurality of dyes further comprises:

20 determining a transmittance of a sample treated with the respective dye from a color image of the treated sample, the image comprising a plurality of pixels, in each of a red, green, and blue channel of an RGB color space and for each pixel of the image so as to form an RGB triplet for each pixel;

25 grouping the RGB triplets according to the minimum transmittance in the red, green, and blue channels for the respective RGB triplet; normalizing each group of RGB triplets by summing the transmittances in each of the respective red, green, and blue channels and then dividing each of the summed transmittances by the number of RGB triplets in the respective group so as to form respective normalized RGB triplets; and tabulating the normalized RGB triplets according to the minimum transmittance 30 of each normalized RGB triplet so as to form the correspondence table for

the dye, the correspondence table extending in transmittance increments between 0% and 100% transmittance

33. A method according to Claim 32 further comprising capturing an image of
5 the treated sample with a color image acquisition device so as to form a color image of
the treated sample.

34. A method according to Claim 32 further comprising determining, when a
transmittance increment in the correspondence table for a dye is without a normalized
10 RGB triplet, an approximated transmittance in each of the red, green, and blue channels
so as to form an approximated normalized RGB triplet for that transmittance increment.

35. A method according to Claim 34 wherein determining the approximated
normalized RGB triplet further comprises determining a reference transmittance
15 increment having a normalized RGB triplet, both at a higher transmittance increment and
a lower transmittance increment in the correspondence table for the dye, with respect to
the transmittance increment without the normalized RGB triplet, and then interpolating
between respective transmittances in each of the red, green, and blue channels of the
reference transmittance increments so as to form an approximated normalized RGB
20 triplet for the transmittance increment without the normalized RGB triplet.

36. A method according to Claim 32 further comprising establishing a
significance threshold for the number of RGB triplets in a group and, for any group
failing to meet the significance threshold, discarding the RGB triplets therein as being
25 insignificant.

37. A method according to Claim 32 further comprising plotting the RGB
triplets for the pixels of the image in an RGB color space so as to obtain a three-
dimensional RGB representation of the respective dye, prior to normalizing each group of
30 RGB triplets.

38. A method according to Claim 32 further comprising plotting the RGB triplets for the pixels of the images for each of the plurality of dyes in an RGB color space so as to obtain a three-dimensional representation of a combination of the plurality of dyes, prior to normalizing each group of RGB triplets.

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39. A method according to Claim 32 further comprising plotting the normalized RGB triplets in an RGB color space so as to obtain a characteristic RGB path of the respective dye through the RGB color space.

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40. A method according to Claim 32 further comprising plotting the normalized RGB triplets on a one-dimensional scale so as to graphically represent the correspondence table.

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41. A method according to Claim 31 wherein orthogonally adding the correspondence tables of the plurality of dyes further comprises orthogonally adding the correspondence tables of the plurality of dyes according to the Lambert-Beer law.

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42. A method according to Claim 31 wherein forming a correspondence table further comprises determining an optical density corresponding to the transmittance in each of the red, green, and blue channels of the respective RGB triplet such that the optical densities of the respective RGB triplets are added according to the Lambert-Beer law when orthogonally adding the correspondence tables.

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43. A method according to Claim 31 further comprising plotting the dye space representation of the plurality of dyes on a scale having a number of dimensions corresponding to the number of dyes.

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44. A method according to Claim 31 wherein orthogonally adding the correspondence tables of the plurality of dyes further comprises orthogonally adding the correspondence tables of the plurality of dyes so as to form a resultant correspondence

table for the combined plurality of dyes, the resultant correspondence table comprising a plurality of resultant RGB triplets extending between 0% and 100% transmittance.

45. A method according to Claim 30 further comprising determining an error
5 between each pixel of the image of the sample and the reference model for the combination of the plurality of dyes, the error corresponding to the minimum Euclidean distance between the respective pixel and the reference model.

46. A method according to Claim 45 further comprising plotting the errors for
10 the respective pixels over the image so as to identify any deviations from the reference model.

47. A method according to Claim 45 further comprising identifying an object
15 within the image defined by corresponding pixels and integrating the errors for the pixels comprising the object so as to provide an indication of whether the object is treated with the combination of the plurality of dyes.

48. A method according to Claim 30 wherein comparing each pixel of the image to the reference model further comprises disregarding any normalized RGB triplet
20 within the correspondence table for the respective dye having a transmittance in any of the red, green, and blue channels that is lower than the transmittance in the corresponding channel of the empirical RGB triplet for the pixel.

49. A method according to Claim 33 wherein capturing an image of the
25 treated sample further comprises capturing an image of the sample in a video-microscopy system with at least one of an RGB camera and an RGB-configured scanner.

50. A method according to Claim 33 wherein capturing an image of the
treated sample further comprises illuminating the sample under Koehler illumination
30 conditions.

51. A method according to Claim 33 wherein capturing an image of the treated sample further comprises capturing an image of the sample in a chromatic aberration-corrected video-microscopy system.

5 52. A method according to Claim 33 wherein capturing an image of the treated sample further comprises illuminating the sample with a light source and determining a transmitted intensity of the light transmitted therethrough in each of the red, green, and blue channels.

10 53. A system for modeling a dye indicative of a molecular species in a sample from an image of the sample treated with the dye, said system comprising:

a computer device comprising:

15 a processing portion configured to determine a transmittance of the sample treated with the dye from a color image of the treated sample, the image comprising a plurality of pixels, in each of a red, green, and blue channel of an RGB color space and for each pixel of the image so as to form an RGB triplet for each pixel;

20 a processing portion configured to group the RGB triplets according to the minimum transmittance in the red, green, and blue channels for the respective RGB triplet;

25 a processing portion configured to normalize each group of RGB triplets by summing the transmittances in each of the respective red, green, and blue channels and then dividing each of the summed transmittances by the number of RGB triplets in the respective group so as to form respective normalized RGB triplets; and

30 a processing portion configured to tabulate the normalized RGB triplets according to the minimum transmittance of each normalized RGB triplet so as to form a correspondence table for the dye, the correspondence table extending in transmittance increments between 0% and 100% transmittance.

54. A system according to Claim 53 further comprising a color image acquisition device operably engaged with the computer system and configured so as to be capable of capturing a magnified digital image of the sample, the image acquisition device comprising at least one of an RGB-configured scanner and a microscope operably engaged with an RGB camera.

55. A system according to Claim 54 wherein the computer device further comprises a processing portion configured to direct the image acquisition device to capture the color image of the treated sample.

10 56. A system according to Claim 53 wherein the computer device further comprises a processing portion configured to determine, when a transmittance increment in the correspondence table is without a normalized RGB triplet, an approximated transmittance in each of the red, green, and blue channels so as to form an approximated 15 normalized RGB triplet for that transmittance increment.

20 57. A system according to Claim 56 wherein the processing portion for determining the approximated normalized RGB triplet is further configured to determine a reference transmittance increment having a normalized RGB triplet, both at a higher transmittance increment and a lower transmittance increment in the correspondence table, with respect to the transmittance increment without the normalized RGB triplet, and then 25 to interpolate between the respective transmittances in each of the red, green, and blue channels of the reference transmittance increments so as to form an approximated normalized RGB triplet for the transmittance increment without the normalized RGB triplet.

30 58. A system according to Claim 53 wherein the processing portion for grouping the RGB triplets is further configured to apply a significance threshold for the number of RGB triplets in a group and, for any group failing to meet the significance threshold, to discard the RGB triplets therein as being insignificant.

59. A system according to Claim 53 wherein the computer device further comprises a processing portion configured to plot the RGB triplets for the pixels of the image in an RGB color space so as to provide a three-dimensional RGB representation of the respective dye.

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60. A system according to Claim 53 wherein the computer device further comprises a processing portion configured to plot the normalized RGB triplets in an RGB color space so as to obtain a characteristic RGB path of the respective dye through the RGB color space.

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61. A system according to Claim 53 wherein the computer device further comprises a processing portion configured to plot the normalized RGB triplets on a one-dimensional scale so as to graphically represent the correspondence table.

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62. A system according to Claim 54 wherein the image acquisition device and the computer device are further configured to cooperate to form a chromatic aberration-corrected video-microscopy system.

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63. A system according to Claim 54 further comprising a light source configured to illuminate the sample, wherein the processing portion for determining a transmittance of the treated sample is further configured to direct a measurement of a transmitted intensity of light transmitted through the sample in each of the red, green, and blue channels.

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64. A system according to Claim 63 wherein the light source is further configured to illuminate the sample under Koehler illumination conditions.

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65. A system for modeling a plurality of dyes from a corresponding plurality of samples using an image of each sample, each sample being treated with a different one of the plurality of dyes, said system comprising:

a computer device comprising:

a processing portion configured to form a correspondence table for each of
the plurality of dyes from the image of the respective sample; and
a processing portion configured to orthogonally add the correspondence
tables of the plurality of dyes so as to form a dye space
5 representation of the plurality of dyes, the dye space representation
having one dimension for each dye and providing a reference
model for a combination of the plurality of dyes.

66. A system according to Claim 65 wherein the processing portion for
10 forming a correspondence table for each of the plurality of dyes is further configured to:
determine a transmittance of the sample treated with the dye from a color image
of the respective treated sample, the image comprising a plurality of
pixels, in each of a red, green, and blue channel of an RGB color space
and for each pixel of the image so as to form an RGB triplet for each
15 pixel;
group the RGB triplets according to the minimum transmittance in the red, green,
and blue channels for the respective RGB triplet;
normalize each group of RGB triplets by summing the transmittances in each of
the respective red, green, and blue channels and then dividing each of the
summed transmittances by the number of RGB triplets in the respective
20 group so as to form respective normalized RGB triplets; and
tabulate the normalized RGB triplets according to the minimum transmittance of
each normalized RGB triplet so as to form the correspondence table for
the respective dye, the correspondence table extending in transmittance
25 increments between 0% and 100% transmittance.

67. A system according to Claim 65 further comprising a color image
acquisition device operably engaged with the computer device and configured so as to be
capable of capturing a magnified digital image of each respective sample, the image
30 acquisition device comprising at least one of an RGB-configured scanner and a
microscope operably engaged with an RGB camera.

68. A system according to Claim 67 wherein the computer device further comprises a processing portion configured to direct the image acquisition device to capture the color image of the respective treated sample.

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69. A system according to Claim 66 wherein the computer device further comprises a processing portion configured to determine, when a transmittance increment in the correspondence table is without a normalized RGB triplet, an approximated transmittance in each of the red, green, and blue channels so as to form an approximated normalized RGB triplet for that transmittance increment.

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70. A system according to Claim 69 wherein the processing portion for determining the approximated normalized RGB triplet is further configured to determine a reference transmittance increment having a normalized RGB triplet, both at a higher transmittance increment and a lower transmittance increment in the correspondence table, with respect to the transmittance increment without the normalized RGB triplet, and then to interpolate between the respective transmittances in each of the red, green, and blue channels of the reference transmittance increments so as to form an approximated normalized RGB triplet for the transmittance increment without the normalized RGB triplet.

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71. A system according to Claim 66 wherein the processing portion for forming a correspondence table for each of the plurality of dyes is further configured to apply a significance threshold for the number of RGB triplets in a group and, for any group failing to meet the significance threshold, to discard the RGB triplets therein as being insignificant.

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72. A system according to Claim 66 wherein the computer device further comprises a processing portion configured to plot the RGB triplets for the pixels of the image in an RGB color space so as to provide a three-dimensional RGB representation of the respective dye.

5 73. A system according to Claim 66 wherein the computer device further comprises a processing portion configured to plot the RGB triplets for the pixels of the images for each of the plurality of dyes in an RGB color space so as to obtain a three-dimensional representation of a combination of the plurality of dyes.

10 74. A system according to Claim 66 wherein the computer device further comprises a processing portion configured to plot the normalized RGB triplets in an RGB color space so as to obtain a characteristic RGB path of the respective dye through the RGB color space.

15 75. A system according to Claim 66 wherein the computer device further comprises a processing portion configured to plot the normalized RGB triplets on a one-dimensional scale so as to graphically represent the correspondence table.

20 76. A system according to Claim 65 wherein the processing portion for orthogonally adding the correspondence tables of the plurality of dyes is further configured to orthogonally add the correspondence tables of the plurality of dyes according to the Lambert-Beer law.

25 77. A system according to Claim 65 wherein the computer device further comprises a processing portion configured to plot the dye space representation of the plurality of dyes on a scale having a number of dimensions corresponding to the number of dyes.

30 78. A system according to Claim 65 wherein the processing portion for orthogonally adding the correspondence tables of the plurality of dyes is further configured to orthogonally add the correspondence tables of the plurality of dyes so as to form a resultant correspondence table for the combined plurality of dyes the resultant correspondence table comprising a plurality of resultant RGB triplets extending between 0% and 100% transmittance.

79. A system according to Claim 67 wherein the image acquisition device and the computer device are further configured to cooperate to form a chromatic aberration-corrected video-microscopy system.

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80. A system according to Claim 66 wherein the processing portion for forming a correspondence table for each of the plurality of dyes is further configured to direct a measurement of a transmitted intensity of light transmitted through the sample in each of the red, green, and blue channels.

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81. A system according to Claim 66 wherein the computer device further comprises a processing portion configured to direct a light source to illuminate the sample under Koehler illumination conditions.

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82. A system for determining an amount of at least one molecular species comprising a sample, each molecular species being indicated by a dye, from an image of the sample captured by an image acquisition device, the image comprising a plurality of pixels, said system comprising:

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a computer device comprising:

a processing portion configured to form a dye space representation of a plurality of dyes, each dye having a corresponding correspondence table comprising a plurality of normalized RGB triplets, the dye space representation having one dimension for each dye and providing a reference model for a combination of the plurality of dyes;

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a processing portion configured to compare each pixel of the image of the sample, the sample being treated by the combination of the plurality of dyes, to the reference model for the combination of the plurality of dyes, each pixel having a color defined by an RGB triplet, so as to determine an optimal combination of normalized RGB triplets from the respective correspondence tables of the dyes

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producing the color of the respective pixel, the normalized RGB triplets of the optimal combination being identifiable according to the respective dye; and

5 a processing portion configured to form an artificial image of the sample, the artificial image corresponding to the sample image, from the normalized RGB triplets for each dye determined from the optimal combination, the artificial image thereby indicating a distribution of the respective dye over the sample image and facilitating determination of the amount of the corresponding molecular species.

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83. A system according to Claim 82 wherein the processing portion for forming a dye space representation is further configured to:

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form a correspondence table for each of the plurality of dyes; and orthogonally add the correspondence tables of the plurality of dyes so as to form the dye space representation of the plurality of dyes.

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84. A system according to Claim 83 wherein the processing portion for forming a dye space representation is further configured to form a correspondence table for each of the plurality of dyes by:

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determining a transmittance of the sample treated with the dye from a color image of the respective treated sample, the image comprising a plurality of pixels, in each of a red, green, and blue channel of an RGB color space and for each pixel of the image so as to form an RGB triplet for each pixel;

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grouping the RGB triplets according to the minimum transmittance in the red, green, and blue channels for the respective RGB triplet; normalizing each group of RGB triplets by summing the transmittances in each of the respective red, green, and blue channels and then dividing each of the summed transmittances by the number of RGB triplets in the respective group so as to form respective normalized RGB triplets; and

tabulating the normalized RGB triplets according to the minimum transmittance of each normalized RGB triplet so as to form the correspondence table for the dye, the correspondence table extending in transmittance increments between 0% and 100% transmittance.

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85. A system according to Claim 83 further comprising a color image acquisition device operably engaged with the computer device and configured so as to be capable of capturing a magnified digital image of each respective sample, the image acquisition device comprising at least one of an RGB-configured scanner and a 10 microscope operably engaged with an RGB camera.

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86. A system according to Claim 85 wherein the computer device further comprises a processing portion configured to direct the image acquisition device to capture the color image of the respective treated sample.

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87. A system according to Claim 84 wherein the computer device further comprises a processing portion configured to determine, when a transmittance increment in the correspondence table is without a normalized RGB triplet, an approximated transmittance in each of the red, green, and blue channels so as to form an approximated normalized RGB triplet for that transmittance increment.

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88. A system according to Claim 87 wherein the processing portion for determining the approximated normalized RGB triplet is further configured to determine a reference transmittance increment having a normalized RGB triplet, both at a higher transmittance increment and a lower transmittance increment in the correspondence table, with respect to the transmittance increment without the normalized RGB triplet, and then to interpolate between the respective transmittances in each of the red, green, and blue channels of the reference transmittance increments so as to form an approximated normalized RGB triplet for the transmittance increment without the normalized RGB 30 triplet.

89. A system according to Claim 84 wherein the processing portion for forming a dye space representation is further configured to apply a significance threshold for the number of RGB triplets in a group and, for any group failing to meet the significance threshold, to discard the RGB triplets therein as being insignificant.

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90. A system according to Claim 84 wherein the computer device further comprises a processing portion configured to plot the RGB triplets for the pixels of the image in an RGB color space so as to provide a three-dimensional RGB representation of the respective dye.

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91. A system according to Claim 84 wherein the computer device further comprises a processing portion configured to plot the RGB triplets for the pixels of the images for each of the plurality of dyes in an RGB color space so as to obtain a three-dimensional representation of a combination of the plurality of dyes.

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92. A system according to Claim 84 wherein the computer device further comprises a processing portion configured to plot the normalized RGB triplets in an RGB color space so as to obtain a characteristic RGB path of the respective dye through the RGB color space.

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93. A system according to Claim 84 wherein the computer device further comprises a processing portion configured to plot the normalized RGB triplets on a one-dimensional scale so as to graphically represent the correspondence table.

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94. A system according to Claim 83 wherein the processing portion for forming a dye space representation is further configured to orthogonally add the correspondence tables of the plurality of dyes according to the Lambert-Beer law.

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95. A system according to Claim 83 wherein the processing portion for forming a dye space representation is further configured to determine an optical density corresponding to the transmittance in each of the red, green, and blue channels of the

respective RGB triplet such that the optical densities of the respective RGB triplets are added according to the Lambert-Beer law when orthogonally adding the correspondence tables.

5 96. A system according to Claim 82 wherein the computer device further comprises a processing portion configured to plot the dye space representation of the plurality of dyes on a scale having a number of dimensions corresponding to the number of dyes.

10 97. A system according to Claim 83 wherein the processing portion for forming a dye space representation is further configured to orthogonally add the correspondence tables of the plurality of dyes so as to form a resultant correspondence table for the combined plurality of dyes, the resultant correspondence table comprising a plurality of resultant RGB triplets extending between 0% and 100% transmittance.

15 98. A system according to Claim 82 wherein the computer device further comprises a processing portion configured to determine an error between each pixel of the image of the sample and the reference model for the combination of the plurality of dyes, the error corresponding to the minimum Euclidean distance between the respective 20 pixel and the reference model.

25 99. A system according to Claim 98 wherein the computer device further comprises a processing portion configured to plot the errors for the respective pixels over the image so as to identify any deviations from the reference model.

30 100. A system according to Claim 98 wherein the computer device further comprises a processing portion configured to identify an object within the image defined by corresponding pixels and to integrate the errors for the pixels comprising the object so as to provide an indication of whether the object is treated with the combination of the plurality of dyes.

101. A system according to Claim 82 wherein processing portion for comparing each pixel of the image to the reference model is further configured to disregard any normalized RGB triplet within the correspondence table for the respective dye having a transmittance in any of the red, green, and blue channels that is lower than the 5 transmittance in the corresponding channel of the empirical RGB triplet for the pixel.

102. A system according to Claim 85 wherein the image acquisition device and the computer device are further configured to cooperate to form a chromatic aberration-corrected video-microscopy system.

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103. A system according to Claim 84 further comprising a light source configured to illuminate the sample.

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104. A system according to Claim 103 wherein the light source is further configured to illuminate the sample under Koehler illumination conditions.

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105. A system according to Claim 84 wherein the processing portion for forming a dye space representation is further configured to direct a measurement of a transmitted intensity of light transmitted through the sample in each of the red, green, and blue channels.

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106. A computer software program product executable on a computer device and capable of modeling a dye, indicative of a molecular species in a sample, from an image of the sample treated with the dye, said computer software program product comprising:

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an executable portion capable of determining a transmittance of the sample treated with the dye from a color image of the treated sample, the image comprising a plurality of pixels, in each of a red, green, and blue channel of an RGB color space and for each pixel of the image so as to form an RGB triplet for each pixel;

- an executable portion capable of grouping the RGB triplets according to the minimum transmittance in the red, green, and blue channels for the respective RGB triplet;
- an executable portion capable of normalizing each group of RGB triplets by summing the transmittances in each of the respective red, green, and blue channels and then dividing each of the summed transmittances by the number of RGB triplets in the respective group so as to form respective normalized RGB triplets; and
- an executable portion capable of tabulating the normalized RGB triplets according to the minimum transmittance of each normalized RGB triplet so as to form a correspondence table for the dye, the correspondence table extending in transmittance increments between 0% and 100% transmittance.
- 15 107. A computer software program product according to Claim 106 further comprising an executable portion capable of directing a color image acquisition device to capture a magnified digital image of a sample treated with the dye, the image acquisition device comprising at least one of an RGB-configured scanner and a microscope operably engaged with an RGB camera.
- 20 108. A computer software program product according to Claim 106 further comprising an executable portion capable of determining, when a transmittance increment in the correspondence table is without a normalized RGB triplet, an approximated transmittance in each of the red, green, and blue channels so as to form an approximated normalized RGB triplet for that transmittance increment.
- 30 109. A computer software program product according to Claim 108 wherein the executable portion for determining the approximated normalized RGB triplet is further capable of determining a reference transmittance increment having a normalized RGB triplet, both at a higher transmittance increment and a lower transmittance increment in the correspondence table, with respect to the transmittance increment without the

normalized RGB triplet, and then interpolating between the respective transmittances in each of the red, green, and blue channels of the reference transmittance increments so as to form an approximated normalized RGB triplet for the transmittance increment without the normalized RGB triplet.

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110. A computer software program product according to Claim 106 wherein the executable portion for grouping the RGB triplets is further capable of applying a significance threshold for the number of RGB triplets in a group and, for any group failing to meet the significance threshold, discarding the RGB triplets therein as being 10 insignificant.

111. A computer software program product according to Claim 106 further comprising an executable portion capable of plotting the RGB triplets for the pixels of the image in an RGB color space so as to provide a three-dimensional RGB representation of 15 the respective dye.

112. A computer software program product according to Claim 106 further comprising an executable portion capable of plotting the normalized RGB triplets in an RGB color space so as to obtain a characteristic RGB path of the respective dye through 20 the RGB color space.

113. A computer software program product according to Claim 106 further comprising an executable portion capable of plotting the normalized RGB triplets on a one-dimensional scale so as to graphically represent the correspondence table.

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114. A computer software program product according to Claim 107 further comprising an executable portion capable of directing the image acquisition device and the computer device to cooperate to form a chromatic aberration-corrected video-microscopy system.

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115. A computer software program product according to Claim 106 wherein the executable portion for determining a transmittance of the treated sample is further capable of directing a measurement of a transmitted intensity of light transmitted through the sample in each of the red, green, and blue channels.

5

116. A computer software program product according to Claim 106 further comprising an executable portion capable of directing a light source to illuminate the sample under Koehler illumination conditions.

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117. A computer software program product executable on a computer device and capable of modeling a plurality of dyes from a corresponding plurality of samples using an image of each sample, each sample being treated with a different one of the plurality of dyes, said computer software program product comprising:

15

an executable portion capable of forming a correspondence table for each of the plurality of dyes from a magnified digital image of the respective sample captured by an image acquisition device, the image acquisition device comprising at least one of an RGB-configured scanner and a microscope operably engaged with an RGB camera; and

20

an executable portion capable of orthogonally adding the correspondence tables of the plurality of dyes so as to form a dye space representation of the plurality of dyes, the dye space representation having one dimension for each dye and providing a reference model for a combination of the plurality of dyes.

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118. A computer software program product according to Claim 117 wherein the executable portion for forming a correspondence table for each of the plurality of dyes is further capable of:

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determining a transmittance of a sample treated with the respective dye from a color image of the treated sample, the image comprising a plurality of pixels, in each of a red, green, and blue channel of an RGB color space

and for each pixel of the image so as to form an RGB triplet for each pixel;
grouping the RGB triplets according to the minimum transmittance in the red, green, and blue channels for the respective RGB triplet;
5 normalizing each group of RGB triplets by summing the transmittances in each of the respective red, green, and blue channels and then dividing each of the summed transmittances by the number of RGB triplets in the respective group so as to form respective normalized RGB triplets; and tabulating the normalized RGB triplets according to the minimum transmittance of each normalized RGB triplet so as to form the correspondence table for the respective dye, the correspondence table extending in transmittance increments between 0% and 100% transmittance.
10

15 119. A computer software program product according to Claim 118 further comprising an executable portion capable of directing a color image acquisition device to capturing a magnified digital image of each respective sample, the image acquisition device comprising at least one of an RGB-configured scanner and a microscope operably engaged with an RGB camera.

20 120. A computer software program product according to Claim 118 further comprising an executable portion capable of determining, when a transmittance increment in the correspondence table is without a normalized RGB triplet, an approximated transmittance in each of the red, green, and blue channels so as to form an approximated normalized RGB triplet for that transmittance increment.
25

30 121. A computer software program product according to Claim 120 wherein the executable portion for determining the approximated normalized RGB triplet is further capable of determining a reference transmittance increment having a normalized RGB triplet, both at a higher transmittance increment and a lower transmittance increment in the correspondence table, with respect to the transmittance increment without the normalized RGB triplet, and then interpolating between the respective transmittances in

each of the red, green, and blue channels of the reference transmittance increments so as to form an approximated normalized RGB triplet for the transmittance increment without the normalized RGB triplet.

5 122. A computer software program product according to Claim 118 wherein the executable portion for forming a correspondence table for each of the plurality of dyes is further capable of applying a significance threshold for the number of RGB triplets in a group and, for any group failing to meet the significance threshold, to discard the RGB triplets therein as being insignificant.

10

123. A computer software program product according to Claim 118 further comprising an executable portion capable of plotting the RGB triplets for the pixels of the image in an RGB color space so as to provide a three-dimensional RGB representation of the respective dye.

15

124. A computer software program product according to Claim 118 further comprising an executable portion capable of plotting the RGB triplets for the pixels of the images for each of the plurality of dyes in an RGB color space so as to obtain a three-dimensional representation of a combination of the plurality of dyes.

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125. A computer software program product according to Claim 118 further comprising an executable portion capable of plotting the normalized RGB triplets in an RGB color space so as to obtain a characteristic RGB path of the respective dye through the RGB color space.

25

126. A computer software program product according to Claim 118 further comprising an executable portion capable of plotting the normalized RGB triplets on a one-dimensional scale so as to graphically represent the correspondence table.

30

127. A computer software program product according to Claim 117 wherein the executable portion for orthogonally adding the correspondence tables of the plurality of

dyes is further capable of orthogonally adding the correspondence tables of the plurality of dyes according to the Lambert-Beer law.

128. A computer software program product according to Claim 117 further
5 comprising an executable portion capable of plotting the dye space representation of the plurality of dyes on a scale having a number of dimensions corresponding to the number of dyes.

129. A computer software program product according to Claim 117 wherein the
10 executable portion for orthogonally adding the correspondence tables of the plurality of dyes is further capable of orthogonally adding the correspondence tables of the plurality of dyes so as to form a resultant correspondence table for the combined plurality of dyes the resultant correspondence table comprising a plurality of resultant RGB triplets extending between 0% and 100% transmittance.

15 130. A computer software program product according to Claim 119 further comprising an executable portion configured to direct the image acquisition device and the computer device to cooperate to form a chromatic aberration-corrected video-microscopy system.

20 131. A computer software program product according to Claim 118 wherein the executable portion for forming a correspondence table for each of the plurality of dyes is further capable of directing a measurement of a transmitted intensity of light transmitted through the sample in each of the red, green, and blue channels.

25 132. A computer software program product according to Claim 118 further comprising an executable portion capable of directing a light source to illuminate the sample under Koehler illumination conditions.

30 133. A computer software program product executable on a computer device and capable of determining an amount of at least one molecular species comprising a

sample, each molecular species being indicated by a dye, from an image of the sample captured by an image acquisition device, the image comprising a plurality of pixels, said computer software program product comprising:

an executable portion capable of forming a dye space representation of a plurality
5 of dyes, each dye having a corresponding correspondence table comprising a plurality of normalized RGB triplets the dye space representation having one dimension for each dye and providing a reference model for a combination of the plurality of dyes;

an executable portion capable of comparing each pixel of the image of the sample,
10 the sample being treated by the combination of the plurality of dyes, to the reference model for the combination of the plurality of dyes, each pixel having a color defined by an RGB triplet, so as to determine an optimal combination of normalized RGB triplets from the respective correspondence tables of the dyes producing the color of the respective pixel, the normalized RGB triplets of the optimal combination being
15 identifiable according to the respective dye; and

an executable portion capable of forming an artificial image of the sample, the
20 artificial image corresponding to the sample image, from the normalized RGB triplets for each dye determined from the optimal combination, the artificial image thereby indicating a distribution of the respective dye over the sample image and facilitating determination of the amount of the corresponding molecular species.

134. A computer software program product according to Claim 133 wherein the

25 executable portion for forming a dye space representation is further capable of:

forming a correspondence table for each of the plurality of dyes; and

orthogonally adding the correspondence tables of the plurality of dyes so as to
form a dye space representation of the plurality of dyes.

135. A computer software program product according to Claim 134 wherein the executable portion for forming a dye space representation is further capable of forming a correspondence table for each of the plurality of dyes by:

5 determining a transmittance of the sample treated with the dye from a color image of the respective treated sample, the image comprising a plurality of pixels, in each of a red, green, and blue channel of an RGB color space and for each pixel of the image so as to form an RGB triplet for each pixel;

10 grouping the RGB triplets according to the minimum transmittance in the red, green, and blue channels for the respective RGB triplet;

15 normalizing each group of RGB triplets by summing the transmittances in each of the respective red, green, and blue channels and then dividing each of the summed transmittances by the number of RGB triplets in the respective group so as to form respective normalized RGB triplets; and

20 tabulating the normalized RGB triplets according to the minimum transmittance of each normalized RGB triplet so as to form the correspondence table for the dye, the correspondence table extending in transmittance increments between 0% and 100% transmittance.

25 136. A computer software program product according to Claim 135 further comprising an executable portion capable of directing a color image acquisition device to capturing a magnified digital image of each respective sample, the image acquisition device comprising at least one of an RGB-configured scanner and a microscope operably engaged with an RGB camera.

30 137. A computer software program product according to Claim 135 further comprising an executable portion capable of determining, when a transmittance increment in the correspondence table is without a normalized RGB triplet, an approximated transmittance in each of the red, green, and blue channels so as to form an approximated normalized RGB triplet for that transmittance increment.

138. A computer software program product according to Claim 137 wherein the executable portion for determining the approximated normalized RGB triplet is further capable of determining a reference transmittance increment having a normalized RGB triplet, both at a higher transmittance increment and a lower transmittance increment in 5 the correspondence table, with respect to the transmittance increment without the normalized RGB triplet, and then interpolating between the respective transmittances in each of the red, green, and blue channels of the reference transmittance increments so as to form an approximated normalized RGB triplet for the transmittance increment without the normalized RGB triplet.

10

139. A computer software program product according to Claim 135 wherein the executable portion for forming a dye space representation is further capable of applying a significance threshold for the number of RGB triplets in a group and, for any group failing to meet the significance threshold, discarding the RGB triplets therein as being 15 insignificant.

140. A computer software program product according to Claim 135 further comprising an executable portion capable of plotting the RGB triplets for the pixels of the image in an RGB color space so as to provide a three-dimensional RGB representation of 20 the respective dye.

141. A computer software program product according to Claim 135 further comprising an executable portion capable of plotting the RGB triplets for the pixels of the images for each of the plurality of dyes in an RGB color space so as to obtain a three- 25 dimensional representation of a combination of the plurality of dyes.

142. A computer software program product according to Claim 135 further comprising an executable portion capable of plotting the normalized RGB triplets in an RGB color space so as to obtain a characteristic RGB path of the respective dye through 30 the RGB color space.

143. A computer software program product according to Claim 135 further comprising an executable portion capable of plotting the normalized RGB triplets on a one-dimensional scale so as to graphically represent the correspondence table.

5 144. A computer software program product according to Claim 134 wherein the executable portion for forming a dye space representation is further capable of orthogonally adding the correspondence tables of the plurality of dyes according to the Lambert-Beer law.

10 145. A computer software program product according to Claim 134 wherein the executable portion for forming a dye space representation is further capable of determining an optical density corresponding to the transmittance in each of the red, green, and blue channels of the respective RGB triplet such that the optical densities of the respective RGB triplets are added according to the Lambert-Beer law when 15 orthogonally adding the correspondence tables.

20 146. A computer software program product according to Claim 133 further comprising an executable portion capable of plotting the dye space representation of the plurality of dyes on a scale having a number of dimensions corresponding to the number of dyes.

25 147. A computer software program product according to Claim 134 wherein the executable portion for forming a dye space representation is further capable of orthogonally adding the correspondence tables of the plurality of dyes so as to form a resultant correspondence table for the combined plurality of dyes, the resultant correspondence table comprising a plurality of resultant RGB triplets extending between 0% and 100% transmittance.

30 148. A computer software program product according to Claim 133 further comprising an executable portion capable of determining an error between each pixel of the image of the sample and the reference model for the combination of the plurality of

dyes, the error corresponding to the minimum Euclidean distance between the respective pixel and the reference model.

149. A computer software program product according to Claim 148 further
5 comprising an executable portion capable of plotting the errors for the respective pixels over the image so as to identify any deviations from the reference model.

150. A computer software program product according to Claim 148 further comprising an executable portion capable of identifying an object within the image
10 defined by corresponding pixels and integrating the errors for the pixels comprising the object so as to provide an indication of whether the object is treated with the combination of the plurality of dyes.

151. A computer software program product according to Claim 133 wherein
15 executable portion for comparing each pixel of the image to the reference model is further capable of disregarding any normalized RGB triplet within the correspondence table for the respective dye having a transmittance in any of the red, green, and blue channels that is lower than the transmittance in the corresponding channel of the empirical RGB triplet for the pixel.

20
152. A computer software program product according to Claim 136 further comprising an executable portion capable of directing the image acquisition device and the computer device to cooperate to form a chromatic aberration-corrected video-microscopy system.

25
153. A computer software program product according to Claim 135 further comprising an executable portion capable of directing a light source to illuminate the sample under Koehler illumination conditions.

30
154. A computer software program product according to Claim 135 wherein the executable portion for forming a dye space representation is further capable of directing a

measurement of a transmitted intensity of light transmitted through the sample in each of the red, green, and blue channels.

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